STATUS REPORT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Grant NGR-14-001-054

PLANE POLARIZATION IN MAGNETIC VARIABLES

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December 10, 1965

NASA Grant NGR-14-001-054

The attached paper presented at the NASA Symposium on Magnetic Variables describes the research performed on the above grant. This paper will be published in the proceedings of the symposium.

We are continuing to search for variable polarization to magnetic variable stars.

PLANE POLARIZATION IN MAGNETIC VARIABLES

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In 1961 Thiessen[1] suggested that the plane polarization observed in reddened stars was not interstellar in origin but was associated with the magnetic properties of the stars. To support his thesis, he reported that the magnetic variable, HD71866, indeed had a variable polarization. Although his thesis never received favorable support, his observations of HD71866 have never been confirmed or repudiated. More recently, Miss Polosukhina[2] reported observations on HD215441 from which she concluded "that the variations found in the polarized emission of HD215441 are far in excess of any possible error in observations." Figure 1 shows some of the evidence on which the above statement was made. These observations stimulated correspondence between Mr. Cameron and Mr. Hiltner that resulted in an initiation of a polarimetric program at Yerkes Observatory of this and other stars.

The telescope we use for this program is the rotatable one of 24-inches in aperature.[3] The polarimeter is a Wollaston analyzer with two refrigerated RCA6199 photomultipliers. The outputs of the two photomultipliers are measured with two dc amplifiers followed by two voltage to frequency converters and scalers. To introduce more stability in the electronics for the brighter stars, we have attempted to pulse count with a resolution of the order of 10 n sec. However, the system has not performed to our complete satisfaction since no well defined plateau is obtained for the counted number of photoelectrons. The whole telescope tube, including the primary and secondary mirrors, can be rotated on the optical axis. The purpose of this is to remove systematic errors that may arise in the mirror system. The instrument seems to be entirely successful in this regard since the systematic

error is no greater than 0.0001 mag. The National Science Foundation kindly made this telescope possible.

Figure 2 shows the accuracy obtained with the instrument when observations are made at 12 position angles of 20 seconds each. You will note that the errors follow a straight line until we reach the brighter stars where the observed points fall above the predicted accuracy. The cause of this departure is not entirely known but may have one of several origins. Among them are improper illumination of the photomultipliers, either through imperfections in the optical surfaces or through non-uniform cathode sensitivity, or instability in the electronics including the photomultipliers. The dashed line to the right refers to the theoretical accuracy assuming a 10 percent photocathode and perfect recording of the photoelectrons. Low quantum or collection efficiency of the photomultipliers is the most obvious explanation but not necessarily the complete one.

During the past few months we have made polarimeter observations of a number of magnetic stars that have established periods. HD 215441 has been observed more extensively and will be discussed in more detail.[4] Figure 3 shows the light curve of HD 215441 as observed by Jarzebowski,[5] the polarimetric observations of Miss Polosukhina plotted against phase and the polarimetric observations obtained at Yerkes. It is obvious that there is no variation of polarization with phase in either of the two sets of polarimetric observations. One must note, however, that up to the present time, the magnetic field has not been shown to be variable in a periodic sense.

The question then arises whether the variations in polarization on a single night reported by Miss Polosukhina are real or are only statistical fluctuations. Some feeling for their reliability can be obtained by assuming that the polarization

is constant and then compute the mean error of a single observation. The results are most interesting for the computed mean error is equal to the published error, 0.003 magnitudes. Whether or not this is coincidental is difficult to say for the type of error is not given nor the stellar magnitude to which the published error applies. As you saw earlier the accuracy is and must be a function of the magnitude. Under ideal conditions the theoretical accuracy for a star of the magnitude of HD 215441, exposure time and size of telescope used by Miss Polosukhina is approximately 0.002 magnitude. A more accurate estimate cannot be given for lack of instrumental and procedural details. Therefore, an accuracy of 0.003 mag. for the observation by Miss Polosukhina can be considered good. Unfortunately the conclusions in the paper must be challenged for the reported changes in the polarization can be adequately accounted for by statistical fluctuations caused by the limited accuracy of the observations.

Four other peculiar A stars with well established periods but not, necessarily with periodic variable magnetic fields, have been observed at Yerkes in sufficient detail to make some comments.[6] Figure 4 shows HD 173650, HD 18296 (21 Per) HD 196502 (73 Dra) and HD 224801. The periods are 10.1, 1.73, 20.3, and 3.7 days respectively. The polarizations in all cases are very small and show no variation within the accuracy of the observations.

There have been observations by other observers that have or have not been reported in the literature. In a recent issue of the Astrophysical Journal, Serkowski[7] reported negative results for 53 Cam, HD 98088, ϵ UMa, 78 Vir, β CrB and γ Ser. There was one exception. Serkowski reported that "some very little changes may be present for the magnetic variable HD 71866." This, of course, returns us to the reliability of the original Thiessen observations.

Again, because of the limited published detail of the original observations, it is difficult to establish the degree of reliability of the observations of HD 71866 by Thiessen. If once again one assumes that the polarization is constant, we find from the 10 observations that the mean error is 0.0012 mag. On the assumption that the drawn curve in Thiessen's illustration is the correct one, the mean error is 0.0004 mag. Our present observational procedure as discussed earlier, gives an error of about 0.0018 for a star equal to the magnitude of HD 71866, and 0.0006 for the theoretical accuracy. Consequently, if Thiessen used a telescope of similar aperature and followed a smiliar procedure, it is not inconsistent to again interpret the reported variations as statistical fluctuations.

All reports by other observers are negative. The only evidence for any variable polarization is centered about HD 71866, and this evidence can be challenged; Thiessen's on the basis of overanalysis of the observations and Serkowski's on the basis of insufficient evidence. It seems most logical to conclude at this time that a variable polarization in a magnetic variable has not been established. However, in spite of this pessimistic point of view, we plan to continue observations of selected stars with concentration on stars with well established periodic variation in magnetic field. HD 71866 with a period of 6.8 days and a magnetic field change from -2 to +2 kilogauss and α^2 CVn with a period of 5.5 days and a magnetic field change from -4 to +5 kilogauss are candidates for concentrated observations.

This work was supported in part by NASA grant NGR-14-001-054.

REFERENCES

1. Thiessen, G., Astron. Abh. Hamburg, 5, Nr. 9, 1961.

2. Polosukhina, N. S., A. Z. 40, 651, 1963.

3. Hiltner, W. A. and Schild, R., Sky and Telescope, 30, 144, 1965.

4. See Babcock, H. W., Ap. J., 132, 521, 1960 for a discussion of the magnetic field.

5. Jarzebowski, T., Acta Astronomica, 10, 119, 1960.

6. For a discussion of the magnetic fields associated with these and other stars, we refer the reader to Babcock, H. W., Ap. J. Suppl., 3, 141, 1957.

7. Serkowski, K., Ap. J., 142, 793, 1965.

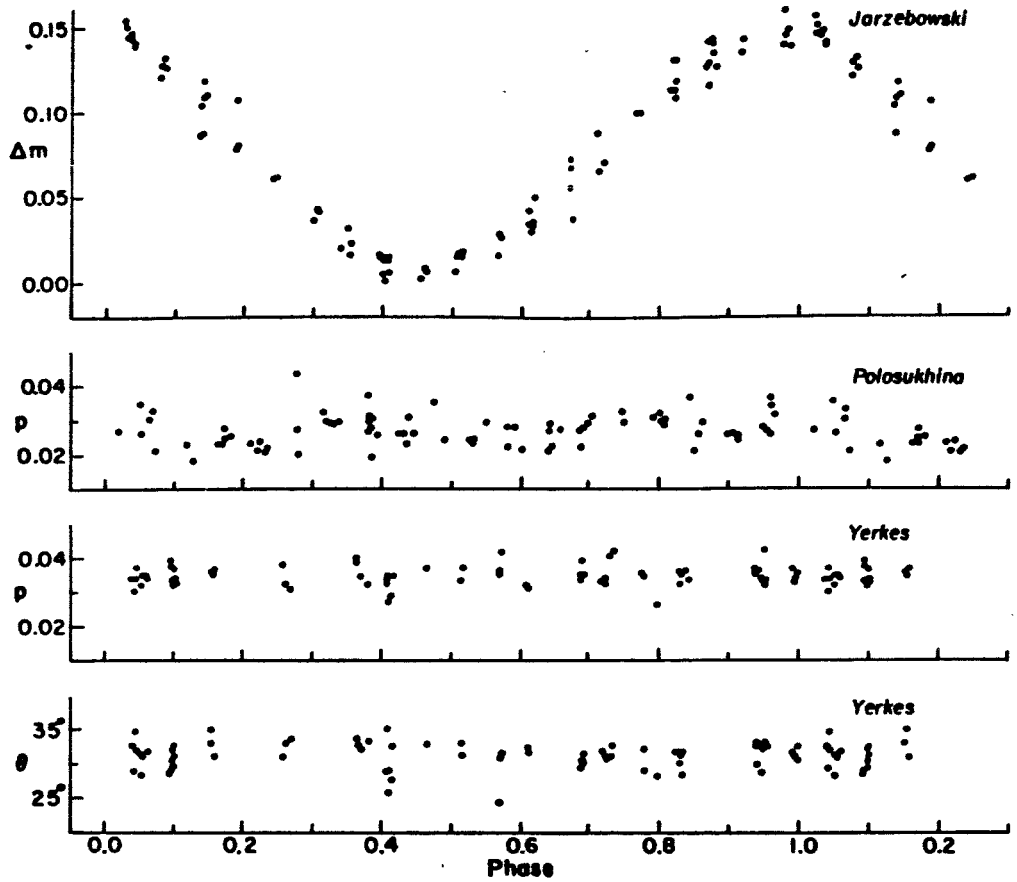
CAPTIONS

Fig. 1 - The observed accuracy with the 24-inch rotatable telescope with two RCA 6199 photomultipliers. The dashed line refers to 10 percent photocathodes with perfect registration of photoelectrons.

Fig. 2 - Individual nightly observations of HD 215441 by Miss Polosukhina. The abscissa intervals correspond to one hour.

Fig. 3 - Observations of HD 215441.

Fig. 4 - Polarimetric observations of HD 173650, 18296 (21 Per), 196502 (73 Dra) and 224801.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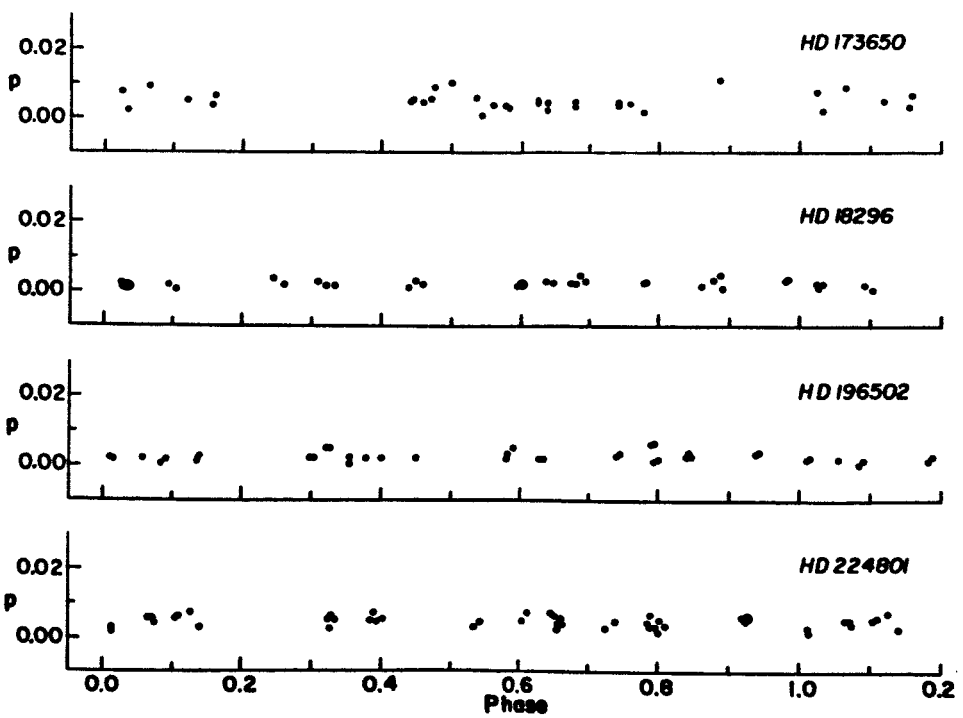
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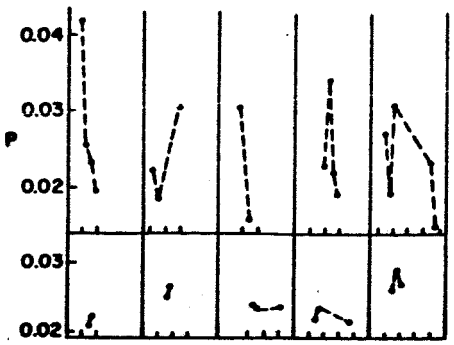
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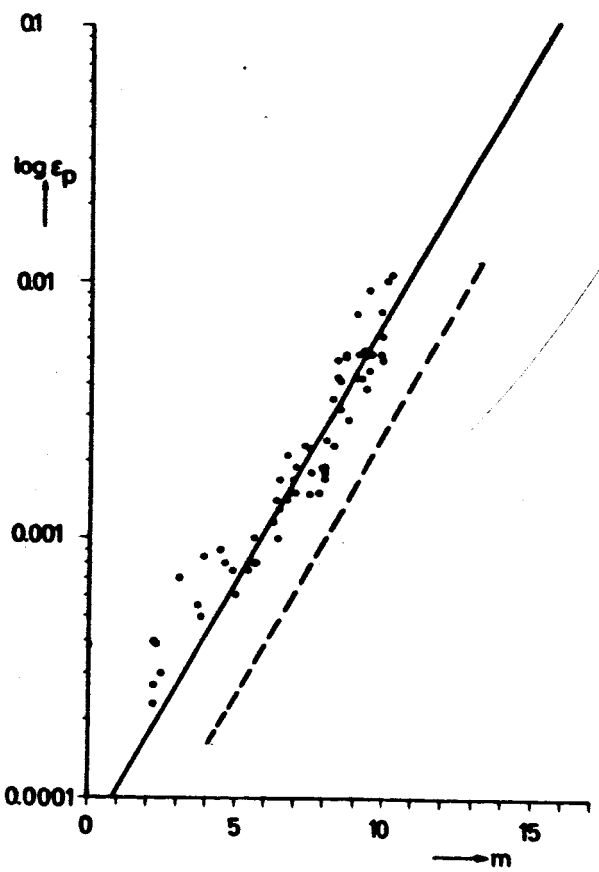
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